An Analysis of
Presidential Approval Ratings
(1945 – 1974)

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STA 104 – B02

Questions of Interest

1.) Is there a significant difference in presidential approval ratings between democratic and republican presidents?
2.) Is there any significant differences in presidential approval ratings between quarters?
3.) Is there any monotonic relationship between presidential approval ratings and GDP?

Statistical Methods

1.) I will use a permutation test with the sum of approval ratings under a democratic president as the test statistic and Wilcoxon rank-sum test (also known as the Mann-Whitney test).
2.) I will use a Kruskal-Wallis test to check for any significant differences and then Tukey's Honest Significance Difference procedure to find specific differences in approval ratings between quarters.
3.) I will use a test for Spearman rank correlation since our data contains ties. I will also use a plot with Loess Regression applied to see if the data follows any particular pattern.

Question 1

My population is the set of all observations of approval ratings. I am trying to testing to see if one party's approval rating is significantly higher than the other. Assumptions for these procedures are that the approval ratings are independent and identically distributed and that the data is paired and comes from the same population. This assumption is reasonable because to obtain the approval ratings, the samplers had to take a random sample from the population of U.S. citizens for each quarter.

H_0 = There is no significant difference between approval ratings between democratic and republican presidents.

H_A = There is a significant difference between approval ratings between democratic and republican presidents.

2-sample Permutation test: Test statistic: 3490 P-value: 0.9096

(Based on a random sample of size 10,000 from the permutation distribution of approval ratings)

Wilcoxon Rank-Sum test: Test statistic: 1533.5 P-value: 0.9136

Since our p-values are greater than $\alpha = 0.05$, we fail to reject the null hypothesis and conclude that there is no significant difference between approval ratings between democratic and republican presidents.

Question 2

My population is the set of all approval ratings. I am testing to see if approval rating differs among quarters of a year. That is, if approval ratings are higher or lower than usual in certain times of the year. Assumptions required are that the data is i.i.d. which is safe to assume since we are working with the same data as in Question 1.

H_0 = There is no difference in approval ratings among the quarters of a year.

H_A = There is a difference in approval ratings among the quarters of a year.

Kruskal-Wallis chi-squared = 56.8631, df = 49, p-value = 0.2056

Tukey's HSD test shows no significant difference between any groups (lowest p-value: 0.4793)

Since our p-values are greater than α = 0.05, we fail to reject the null hypothesis and conclude that there is no difference in approval ratings among the quarters of a year.

Question 3

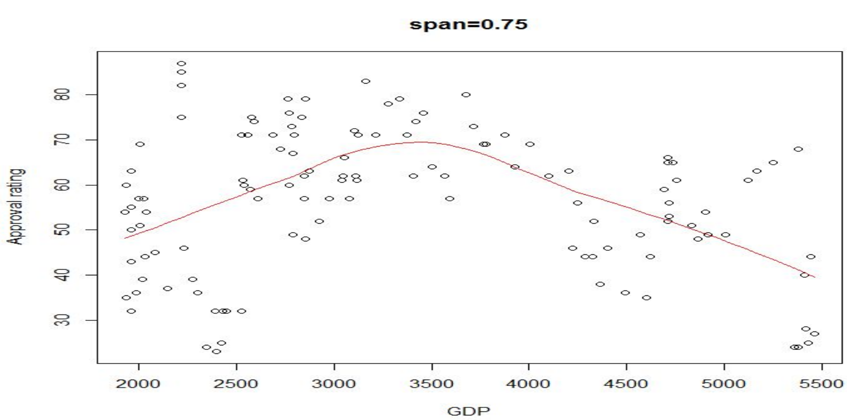
My populations are presidential approval ratings and GDP. I am testing to see if there is any monotonic between GDP and approval ratings. For a Spearman rank correlation test, we assume there is a monotonic relationship between GDP and approval ratings. This assumption is not met looking at the plot since there is a clear non-monotonic relationship. Since our sample size is large (n=120), I will use the normal approximation to find the p-value.

H_0 = No association between GDP and approval ratings.

H_A = Positive association between GDP and approval ratings.

Test statistic: -0.1377827 P-value: 0.9335845

Since our p-value is greater than α = 0.05, we fail to reject the null hypothesis and conclude that there is no monotonic association between GDP and approval ratings. The plot with Loess Regression shows a quadratic relationship:



Conclusion

From my analysis, I have found that there seems to be no significant relationship between approval ratings when compared to political party, quarters of a year, or GDP. My results may be flawed as it is hard to determine whether all observations are truly independent because time and other factors must be accounted for when looking at the data (historical events can affect some values for example). To fully analyze this data would require some knowledge of time-series analysis which I have not learned yet.

Code Appendix

#Problem 1

```
democratic.approval = pres$approval[pres$party == 1]
republican.approval = pres$approval[pres$party == 2]

pvalCalc = function(teststat, teststat.obs){
  num.GreaterThan = length(which(teststat >= teststat.obs))
  pval = num.GreaterThan / length(teststat)
  return(pval)
}

permTestSum = function(R, x, y){
  data = c(x, y)
  teststat.obs = sum(x)
  teststat = sapply(1:R, function(i){
    Sum = sum(sample(data, size = length(x), replace = FALSE))
    return(Sum)
  })
  pval = pvalCalc(teststat, teststat.obs)
  return(pval)
}

permTestSum(10000 ,democratic.approval, republican.approval)
wilcox.test(democratic.approval, republican.approval, alternative = "greater")
```

#Problem 2

```
#test relationship between quarters and approval rating
quarter1.approval = pres$approval[pres$quarter == 1]
```

```
quarter2.approval = pres$approval[pres$quarter == 2]
quarter3.approval = pres$approval[pres$quarter == 3]
quarter4.approval = pres$approval[pres$quarter == 4]

x = c(quarter1.approval, quarter2.approval, quarter3.approval, quarter4.approval)
grps = rep(1:4, each = 30)
k = 4

kruskal.test(pres$quarter, pres$approval)

##
###### Utility functions for Tukey HSD Permutation test for Multiple Comparisons
##
"getmaxTij" <- function(x, grps, MSE)
{
 # estimate the maximum of Tij (pairwise mean diff) of a given data x
 trtmeans = getmeans(x,grps)
 nn = table(factor(grps))
 k = length(trtmeans)
 Tijs = matrix(NA,k,k)
 for (i in 2:k) {
  for (j in 1:(i-1)){
   Tijs[i,j] = abs(trtmeans[i] - trtmeans[j])/sqrt(MSE/2 * (1/nn[i] + 1/nn[j]))
  }}
 return(max(Tijs,na.rm=T))
}

"perm.approx.maxTij" <- function(x,grps,MSE,R)
```

```
{
  ### obtain the null permutation distribution of maxTij
  results = rep(NA,R)
  for (i in 1:R) results[i] = getmaxTij(x[sample(1:(length(x)),length(x))],grps,MSE)
  return(results)
}

##
###### Tukey HSD Permutation test for Multiple Comparisons
##
"Tukey.HSD" <- function(x, grps, k, alpha=0.05, R=1000)
{
  #Tukey's HSD
  #summary(aov(x ~ factor(grps)))
  nn = table(factor(grps))
  trtmeans = getmeans(x,grps)

  (MSE = summary(aov(x ~ factor(grps)))[[1]][2,3])
  ### observed Tij
  Tijs = matrix(NA,k,k)
  for (i in 2:k){
    for (j in 1:(i-1)){
      Tijs[i,j] = abs(trtmeans[i] - trtmeans[j])/sqrt(MSE/2 * (1/nn[i] + 1/nn[j]))
    }}

  ### observed maxTij
  #getmaxTij(x,grps,MSE)
```

```
  ### permutation maxTij
  perm.maxTij = perm.approx.maxTij(x,grps,MSE,R)

  pvalsTij = matrix(NA,k,k)
  for (i in 2:k){
    for (j in 1:(i-1)){
      pvalsTij[i,j] = mean(perm.maxTij >= Tijs[i,j])
    }}

  ### compare the pairwise pvalue with alpha
  sig = (pvalsTij <= alpha)

  out = list(sig=sig, pvalsTij= pvalsTij)
  return(out)
}

Tukey.HSD(x, grps, k, alpha = 0.05, R = 10000)
```

#Problem 3

```
x = pres$gdp
y = pres$approval

r.obs = cor(pres$gdp, pres$approval)
n = length(pres$gdp)
Z.value = r.obs*sqrt(n-1)
p.value = pnorm(Z.value, lower.tail = FALSE)
```

```
lo = loess(y~x, span = 0.75)
plot(y~x, main="span=0.75", xlab = "GDP", ylab = "Approval rating")
newx = seq(min(x), max(x), length=50)
pred = predict(lo, data.frame(x = newx))
lines(pred~newx, col=2, lwd=1.5)
```